

S H O R T
O B S E R V A T I O N S
O N T H E

Principles and moving Powers

ASSUMED BY THE PRESENT

SYSTEM of PHILOSOPHY.

— Atlas en ipse laborat,
Vixque suis humeris labentem sustinet axem.

By an IMPARTIAL ENQUIRER.



L O N D O N :

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L O N D O N

OBSERVATIONS

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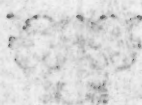
Principles and moving Powers

ASSUMED BY THE PRESENT

SYSTEM OF PHILOSOPHY.

By the Author of the Inquiry into the Nature and Connexion of the Human Mind.

By an IMPARTIAL ENQUIRER.



L O N D O N

Printed by W. KILGOUR, at the Church-Yard, in Strand.

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P R E F A C E.

TH*ERE* is no doubt of it, truth is a most excellent thing, and worthy of all the encomiums bestowed upon it: It is cloathed with all the excellency that can possibly be ascribed to it. But then, when we descend to particulars, it is no easy matter to determine what is the truth. Such things are self-evident and obvious to our senses, tho' they may be constituted truths by forming them into propositions, yet they are generally considered as facts, from whence other no less certain, tho' less obvious, conclusions may be inferred. It is such certainties as these that first assume the name of truth. But such truths are only known to those who make the discovery, or who have examined and tried the ratio which leads to the conclusion.

The rational powers of man are bestowed upon him to be his pilot either in discovering such truths, or in examining the evidence and certainty of such as are discovered to him. That man's reason then, must be far gone in a lethargy, who trusts his vessel at sea to the steerage of another. The use of our reason in discovering
A truth,

truth, may well enough be compared to a voyage; but it is a navigation which every one must perform for himself, for as one man cannot manage the course of two ships at the same time, so one man cannot take the steerage of another's understanding. He must then have either a sturdy faith on the infallible capacity of his neighbour, or a mighty indifference about the issue of the voyage, who, in search of truth, can venture himself a passenger with another pilot at the helm.

If therefore I were to define truth, I would call it, That which requires all that scrutiny and examination in order to discover it, which it will stand the test of by examination: Or, what no man can be possessed of, but he who has searched for it, and tried it. Notwithstanding all this wise and plausible ipse dixit of mine, I don't know how it happens, but so it is, that tho' mankind are universally agreed in professing the most pious and inviolable regard for truth, yet such generally is the nature of their zeal for it, that they cannot bear to have it canvassed. It is very uncommon for people to esteem that so precious which is so cheaply come by; for learning what we hold for truth, often cost us no more than taking up with the most common accounts, and the sum of our evidence is, that no body doubts it; or the sanction of an authority, which we must be permitted to presume, all mankind owe an undisputable allegiance to.

It would not be an easy matter to persuade people of this stamp, that they are the greatest enemies

P R E F A C E.

v.

enemies to what they profess the warmest friendship for. Yet there are strong presumptions, that principles which cost people so little are not always infallibly true; and I need go no further, for an example and proof of it, than observe, that among such it is received as a certain maxim, that whoever is so audacious as to examine any doctrine they happen never to have doubted of, must be in a gross error himself.

It is not easy to account for a turn of mind so common among men, unless it is, that we have naturally a passion for being religious and wise, to which two all knowledge may be referred, or at least esteemed so, at as small cost to ourselves as possible. Or perhaps there is an uneasy blank in the mind of man, while unpossessed of certain principles, which either supineness or more important engagements won't permit it to search for; therefore, it lays hold of the first which are offered to it, as necessary conveniences, not because they furnish it with any waking entertainment, but as they accommodate it with pillows and cushions for the repose of the drowsy understanding.

With all this there is one unaccountable thing not uncommon among men, which is, that you shall find numbers of redoubted champions often entering the lists in the defence and support of the honour of truths that they never examined. It had been well for such knights that they had previously bestowed some little pains in getting acquainted with their professed dulcinea. They would not have entered the lists with so many wind-

windmills; they would have spared her the mortification of many of the exploits performed in the pretended defence of her excellency; and they would have saved themselves from many an outrageous combat and disaster, in which her honour was no more concerned with their danger, than the divine legation of Moses is with the descent of Æneas into hell.

One cannot sufficiently applaud the benevolent intentions of the worthy Lord Shaftsbury, who commiserating the misfortunes, and unlucky circumstances, which the adventurers in controversy were frequently exposed to, pointed out a good-natured facetious way of establishing truth, and overthrowing error, which might hurt no body: For who would be offended, nay who would not be pleased to see another indulging himself in one of the innocent and inoffensive pleasures of imagination. But the misfortune is, some people will always be mistaking things, and I dare say his Lordship would be very sorry to see the bad success of his scheme, and the folly produced, both among his friends and foes, by their misapprehending his meaning: The one side foolishly imagining that their own laugh was a test of truth to themselves; and the other exclaiming that ridicule could never be a test of truth, because they themselves could not bear it. But certainly ridicule is an excellent test of truth, and both it, and they who are so happy as to search for it and find it, will stand that test with much the same firmness, as pillars of marble or gates of brass would sustain the shocks of men who were so wise as to essay beating them to pieces with their heads. But

But it may be said, what is all this to the purpose of the following sheets? Why truly, perhaps not much. It must be owned there are many subjects of such small importance to mankind, that it cannot much affect their true happiness or interest, whether they know them, are ignorant of them, or labour under mistakes about them. However, lest I should be suspected of intending under this character to imply a general reflection upon subjects of learning; I profess to be of opinion, that there are no subjects of so little importance as to be unworthy of examination: And, as every decision upon any subject acquires a dignity by bearing the name of a truth, we owe so much reverence to that name, as to enquire into, and defend or reprove the application of it, as we shall find cause.

But as there are some who think that the subject of world making, is one of the most sublime studies and employments of rational minds here, and must constitute their greatest happiness hereafter; I am under no apprehension of falling under any imputation on account of my subject: And every thing considered, I cannot be blamed for fortifying myself against the power of authority, by zealously enforcing the danger of admitting its weight in the establishment and propagation of truth. One has not so much reason to be afraid of ridicule, considering that they may be allowed to laugh without taking offence, who give themselves very little trouble either to think or speak, to the purpose I mean, upon any subject.

There

There is one thing further to be said in favour of scrutinies into subjects, however little their importance may be apprehended to be of, which is, that a man cannot learn to reason strictly and justly, unless he accustom himself to search and enquire upon every subject however uninteresting. Unless a man count it his honour to discover truth in small matters, without leaning to authority, false honour will sometimes prompt him to resist the brightest evidence of it when proposed to him by argument. Therefore, I conclude it is a prudent maxim for people to accustom themselves to search and examine, without the awe of authority in the least cases, that they may not be misled, nor have their faculties dulled thro' want of exercise, when matters of the greatest importance come to be proposed to them.

As I think it might prove no unuseful improvement of the plan of Reviews, and such like publications, and would save the undertakers of these works a good deal of trouble upon some occasions, if authors were to draw up an abridgement or summary of the plan or argument of their productions, within a limited compass proportioned to the size of the work, I shall present the reader with an example of this kind. However small any work may be, such an abstract may prove very convenient to many readers on another account, which I shall give in words of Martial.

Lemmata si quæris cur sint adscripta, docebo:
Ut si malueris, Lemmata sola legas.

§ I. Insists on the insufficiency and inconclusiveness of natural Theology, because no decisive argument ever has been adduced, nor indeed can be, which fairly proves, that either the materials of the universe, or the frame of it, are an effect, or in other words, had a beginning. This argument is urged in several different lights; and while this is the case, it is further alledged, that no presumptions of wisdom, thought, or design, manifested in nature, can document there is a Supreme Being absolutely distinguished from nature, in whom only these powers reside. The wisest of the old philosophers, who confined themselves to the lights of nature and reason, never could go higher than a soul of nature, or of the world; and in fact, that doctrine is strengthened by the hypothesis of these philosophers who introduce the immediate agency of a first intelligent cause, always exerting itself in the course of nature; which consequently establishes the same connection between it and that cause, as is understood to be between soul and body in men and beasts.

II. Space is asserted to be a mere negation, which has no positive properties of its own that can reach our senses or mind; and it is alledged unfair to ascribe to it any properties which matter only can impress us with the ideas of. In this section also some reflections are offered on the infinite divisibility of matter, by which it is alledged, the philosophers can only mean the divisibility of the space matter occupies, tho' they at the same time teach, that space is indivisible or inseparable, which

which comes much to the same purpose. Also a pretty cogent argument is urged against infinite divisibility in any sense, drawn from the relation mathematics has established between distance and power.

III. The properties of matter, or these generally assigned to it, are distinguished into three kinds, and classed in a manner, it is hoped, no person will have any objection to.

IV. The first axiom of the present philosophy, or the vis inertiae, is considered. Rest and motion are maintained to be such opposites, that it implies a contradiction to suppose an equal disposition to either inherent in the same body. The one is maintained to be a positive, which necessarily implies power or momentum; the other a mere negative, which implies no power or momentum in any direction. From the very supposition of creation, it is argued these dispositions cannot be equally natural to matter: Also, from the consideration that all natural life, and all mechanism depends on motion, and not on the inherent properties of matter, it is argued, that motion must be something superadded to matter, and mechanically supported in it. Some presumptions are also offered in favour of a plenum, which indeed the support of motion by mechanism only, necessarily implies.

V. Is intended to prove, that matter containing in itself no momentum of any kind, it can give no resistance to any impression upon it, nor can it continue to exert the effects of that impression;

pression; and therefore the second axiom or general law of motion, or rather the natural symptoms and phenomena from which it is deduced, must arise from the relations all matter we know any thing of stands in with the systematic composition of the universal frame of nature.

VI. *Considers the third axiom of the present philosophy, and demonstrates that the re-action of matter entirely depends upon gravity; consequently if gravity were subtracted, there can be no proof, nor even a ground of presumption adduced, that bodies would exert either resistance or re-action. If that is the case, all the axioms of course fall to the ground, or instead of being absolute laws, become mere phenomena depending upon other causes; which causes it is incumbent upon the philosophers to look for. The ambiguous and evasive terms in which some philosophers chuse to express themselves in, where all the symptoms of proper resistance appear, is likewise remarked upon.*

VII. *From the defined nature of the projeteile power, the author endeavours to prove it can never ballance the power of gravitation, which has opposite or merely negative properties, so as to maintain the motions of the planets. It can never cover its momentum when it is resisted, whereas gravity can: Therefore the constant bending of its direction, which must be equal to a constant proportionable resistance, must uniformly and perpetually weaken its power and strengthen that of gravitation; so that the direction of motion must inevitably fall more and more, and at last*

wholly into the direction of gravitation.—From hence the author maintains, that no power acting upon an orb, in a direction towards its centre of motion, can maintain its projectile motion in the direction of circles; and that no power but a simply resisting one can do it.

VIII. Even upon the supposition that the properties of these powers were similar, that is, equally retained their propensity to motion tho' resisted, the author alledges, such powers could not move the planets in elipses, because in the same proportion that the one vis motrix gains power over the other, in the same proportion does it gain in altering the tendency of motion towards its own direction; and no properties of figures or reasoning from them can explain, how, when a quantity of motion, and also of inclination, is gained by gravitation over projection, the orb will, while these remain unchanged, leave at any point the direction of the moving power that prevails, and recede into the direction of the weaker power; or e contra. The author also examines the phenomena of an experiment produced to illustrate the motions of the planets by the above-mentioned powers.

IX. From the mathematical proportions of the momenta required between gravitation and projection (which the author alledges should be nearly equal) in order to carry the orbs about in nearly circles, it is maintained these two powers cannot be the cause of their motions. Here the author's reasoning rests principally upon the relation of the diagonal to its paral-

parallelogram, and he alledges by comparing the commonly assigned different momenta of these two powers, the ratio of gravitation is not such in proportion to projection, as to bend the direction of the projected body sensibly from the right line.

X. After proposing some of the intricate difficulties which attend the doctrine of absolute and relative motion, and offering two considerations towards solving them, the application of the doctrine of absolute motion to the satellites is examined. Upon this the author argues, that the motion of the moon along with the earth, can neither be owing to her gravitating towards it, nor to a projection impressed upon her along with the earth: Because she has a projection of her own round the earth; and she cannot be so projected as to move in two different orbits at one and the same time, by the vis inertiae continuing on projectile motion round the sun, and another round the earth. From whence it is concluded, that the motion of all the planets must be momentarily guided either by mechanism or a spiritual power.

XI. Examines the first lemma of Sir Isaac Newton's Principia, and shews, that in order to accommodate mathematics to the supposed powers of projection and gravitation, he fairly and expressly reverses the doctrine of infinite divisibility, in other respects maintained by himself and all the mathematicians.

Tho' I had been sufficient for the undertaking,
which

which I am far enough from presuming to be, it would have been foolish enough to have undertaken an examination of the mathematical demonstrations by which that great man adjusts the phenomena of the celestial motions to the principles he assumes, until the natures, powers, and proportions of momentum assigned to each of these moving principles, were first fairly discussed. However, as an ingenious gentleman communicated to me the fallacy which he thought couched in the first lemma of Sir Isaac Newton's Principia, I have taken upon me to annex his demonstration of it, as an instance how the most subtle mathematicians may slip into very palpable inconsistencies. This I say, without any intended disparagement to the exalted genius of Sir Isaac Newton. It may be said of the greatest mathematicians, without the least detraction, as was said of the greatest of poets: Aliquando bonus dormitat Homerus. But one cannot help making a mortifying reflection upon the imperfection of the mathematics, as well as of all other sciences, or rather upon the imbecillity and limited compass of the human mind in all its ultimate researches; when at the same time we find the first principles of mathematics, assuming, and even demonstrating the doctrine of infinite divisibility; and at the same time find the philosophical lemmata of one of the greatest mathematicians ever existed, necessarily implying a denial of the same doctrine.

It has been complained of, that no writer hath appeared against Sir Isaac Newton, or the present philosophy, who has not insisted upon the
term

term attraction, as implying some mutual tendency essential to matter, or some charm or unknown virtue by which it is affected: But in refutation of this, Sir Isaac Newton's writings are appealed to, even as early as his letters to Mr Boyle, in proof that he never meant by attraction, bodies moving towards each other, without being impelled or acted upon by other bodies, or by any other powers of whatever kind. The following observations are founded upon no such exceptions to any terms used by the present philosophy, but upon the natures or properties assigned to the powers, their relations and proportions, and the impossibility of adjusting these to the motions they are supposed to produce.

However, if I were freely to speak my mind, I cannot say the complaint is justly founded. "Possibly, says a very great and highly respectable apologist for Sir Isaac Newton, some unskilful men may have fancied that bodies might attract each other by some charm or unknown virtue, without being impelled or acted upon by other bodies, or by any other powers of whatever kind."—That I dare say no person was ever so unskilful as to suppose; and by the addition of that sentence, the truly valuable author himself seems to intimate his own uncertainty as well as Sir Isaac Newton's, as to the nature and the cause of these powers; whether they are material or mechanical, that is, bodies acting upon bodies; or spiritual, that is, any other power of whatever kind: For we have no comprehension of any power but one or other of these; nay, we may safely venture to pro-

pronounce, there can be no other power in the universe but one or other of them. But if the power which causes attraction or any efficacious properties in bodies is not material, but may, for ought we know, be produced by any other power of whatever kind, then no person can be blamed for calling such power, God,—some unknown virtue, or a mutual tendency essential to matter. It comes to one and the same thing, if it is not material, and we don't know what kind of spiritual power it is.

There is no question Sir Isaac Newton has signified he thought that these powers might arise from the impulses of a subtile ætherial medium, that is diffused over the universe, and penetrates the pores of grosser bodies: But I do not think it was an unjust reflection, one formerly made upon this supposition, that it was only retiring a step farther back into the dark. For it comes all to one, whether the cause of attraction be assigned to grosser bodies themselves, or the impulses of a medium which penetrates them. If the powers of that supposed medium are unmechanical, they must be spiritual: And seeing the medium is only supposed, it is more natural to assign these unmechanical powers to bodies which we know disposed to these motions; than to suppose bodies we do not know ought about, and then assign unmechanical moving powers to them.

*In short, that objection against Sir Isaac Newton's powers of motion, which is complained of, lies shortly thus: As Sir Isaac seems not to have
had*

had any notion of resolving his axioms or relative laws of motion to mechanism, but on the contrary considers them as laws (another word I apprehend for ultimate, spiritual or unmechanical power) the very same objection lies against his impelling etherial medium as against the term attraction.

I shall only add, that Sir Isaac's supposition may be very properly urged with this additional deficiency. If his penetration carried him so far as to suppose such a medium for the maintaining of attraction, gravitation, elasticity, &c. How came he not to suppose that the same medium also might be necessarily concerned in supporting his axioms, the absolute laws of motion, rest, resistance, &c. For the knot does not lie in gravitation or attraction, or any particular kind of motion, but in finding powers to produce and maintain motion in general.

If these are mechanical, it is easy to suppose, tho' we should never be able to explain in what manner, that the Contriver may have adjusted the mechanism to produce all the tendencies of motion observable by creatures. But if they are unmechanical, laws, properties, or whatever we may call them, then there is no occasion for supposing a cause of gravitation, or for taking it amiss to have it called occult quality, unknown virtue, charm, law, or any word we have no meaning to.

*I have only further to add, in relation to the subsequent observations, that the examination of
many*

many of them does not depend upon mathematics at all; and such of them as do, may all be brought to the test of its very first principles and most simple propositions, without the least need for having recourse to these refined depths of geometry, into which few are qualified for penetrating. These, no doubt, have their use, both in enlarging the powers of the mind by exercise, and in extending the compass of its knowledge upon subjects to which geometry can be applied: But it may be received as a self-evident proposition, That the most subtile refinements in any science, can never overthrow, and in effect destroy, what the first and plainest propositions of that science establish. Yet there is nothing more certain than, that there is no science in which men have been conversant, which has not been pursued the length of such vanishing subtilties, as in a manner annihilated the most certain elements of all knowledge. How far Sir Isaac Newton falls under this censure, in resolving the chord, the tangent, and the arc, into the ratio of equality in his lemmata, I shall leave with the judgment of the impartial.

The principal intention of the following observations is, to suggest to the candid enquirers into physics, a fair examination and discussion of the following questions; without regarding the terms in which philosophers affect to express these things. Can there be any conceivable distinction between material motion and activity? Can we have any idea or conception of material power distinct from motion, or a constant *nifus* towards it? Is not continued motion then, a constant exertion

action of power? Is not power inherent in bodies, an active and not a passive property? Can motion be owing to any thing but an active principle residing in matter, if it can continue to move in spaces void of matter; for material activity and motion are the same? Subtract the nifus of gravitation from bodies, can we have any conception of any momentum distinct therefrom, attending them or residing in them, either moving or at rest? If a body or planet have no inclination or tendency to the place it is in, can it have any resistance to being removed to another place? Does not a nifus to rest, or a resistance in matter to change of that state, imply in it a double contradiction; namely, a positive effort to do nothing, and, a supposition that without that nifus it would conceive self-motion? Can physics demonstrate, that a power (projection) which totally loses, and can never recover just as much nifus to motion as it meets with resistance, can co-operate with another power (gravitation) which always retains its whole nifus to motion, however its actual motion may be suspended or resisted, in perpetuating the motion of any body in a direction always common to such powers? Where two unequal powers are concerned in the motion of a projectile, must not its direction be just as much inclined to that of the prevailing power, as the momentum of the prevailing power exceeds that of the weaker? When the direction is always so inclined, can mathematics demonstrate that the weaker power can ever change the inclination of that direction? It is admitted, that the quantity of motion generated by the greater power might, at a given point,

point, carry off a body from the direction it was inclining to, if the prevailing power could be supposed to cease to incline the direction, at least so much, and yet retain its momentum: But can that supposition be made? Can two powers, whose original or incipient momenta bear not to each other, in a second or the smallest given space of time, the proportion of one to 10,000 (I take a definite for a yet uncalculated proportion): Can, I say, powers so proportioned move any projectile in a circle, or in any curve figure, which returns into itself again? Can a body move in two absolute motions, by the power of the vis inertiae, or in two different directions at one and the same time? Or, can the weak inclination of one body tending towards another, at the rate of sixteen feet in a minute, determine that body to conceive all the absolute motion of the other, tho' projected from it at the rate of nearly a thousand miles in the same space of time.

I have no doubt these questions will be carefully and impartially examined and resolved by the Minority, to whom the observations are most respectfully inscribed, by

The AUTHOR.

ERRATA.

Preface, Page 1. Line 7. read such Things as are. Page 11. Line 27, for cover, read recover. Page 14. Line 25, dele at the same time.



S H O R T
O B S E R V A T I O N S
O N T H E
Principles and Moving Powers
A S S U M E D . B Y T H E P R E S E N T
S Y S T E M of PHILOSOPHY.

*Of the Theology deducible from Philosophy, un-
assisted by any other Light.*

WHATEVER **A**LMOST all philosophers introduce the subject of Natural Philosophy with a panegyric upon the utility of that study, as containing in itself evident and sufficient demonstration of the being and perfections of a Creator. Many declamatory volumes might be collected from the writings of philosophers and divines upon this subject; but making proper allowance for the profusion of rhetoric lavished out upon this article, we shall shortly weigh the arguments advanced in support of it, which may all be comprehended under these two :

1st, Every effect must have a cause. 2^d, The works of nature in whole, and in every part, contain evident footsteps of wisdom and design, as well as of power; which necessarily imply the exercise of an infinite mind, employed in establishing the construction and powers of nature.

As to the first, it is allowed that wherever we perceive an *effect*, a *cause* is necessarily implied: But in order to apply the argument to nature, it remains to be proved that it is an *effect*: This the philosophers have hitherto overlooked so unaccountably, that they never yet, that I know of, have attempted it. When that step is once gained, it must be allowed the argument will be immoveably established. But the whole difficulty lies in fixing that point; and the difficulty appears to me so great, that I cannot perceive how it will be surmounted. When a man once acknowledges there is a God, he can rationally admit that works may be done by him, which are infinitely beyond our conception; but a man can never rationally suppose things beyond his own conception, in his progress of reasoning towards the discovery or proof of a God or Creator. Man cannot prove there was a Creator, without first supposing that all things were once nothing; but bringing any thing out of nothing, and reducing any thing to nothing, are equally prerogatives of Infinite power; therefore it is absurd to suppose the one, in order to

to prove the other ; for it is in effect, supposing the very thing you engage to prove.

IN other words, *being* and *nothing* (like good and evil, or light and darkness) are two irreconcilable opposites, and it is impossible for man to conceive they are convertible into one another. Every work of God implies, that the divine conception of it is as foreign and superior to that of creatures, as his power is in executing it : And for a man to pretend to say, that he can conceive the possibility either of bringing *being* out of *nothing*, or of reducing *being* to *nothing*, is saying, he is endowed with the conceptions of God, but only wants his executive power. It is very strange, that reasonable creatures suppose the possibility of annihilation, in order to prove creation, when it requires the supposition of creation just as much, to prove the possibility of the annihilation of any thing.— To suppose an event, which it requires both an infinite conception and power to accomplish, in order to lead a proof of the existence of such capacity and power, is confusion.

LET us take the subject in another light : What carries in itself no marks of its coming to nothing, can carry no characters of its having once been nothing : What bears in itself no sign of its dissolution or ending, can bear no evidence of its having had a beginning : And what contains in itself no evidence of its commencement, can yield no intimation of its being an effect. Whether we apply
this

this reasoning to universal nature, considered abstractly as matter, or complexly, as matter forming one vast incomprehensible system of activity and life, the conclusion is the same.

MEN's reason is generally blind on that side which flatters their own capacity; because we have been informed, and accustomed to admit, of the possibility of annihilation, therefore we boast of it as a precious stone wrought out of the quarry of our own conceptions. The properties which characterize matter, such as extension, solidity, figure, &c. imply no symptoms which can enable us to infer, or even suggest to ourselves, the idea of their mutability, or of their ever failing:— Now if reason cannot possibly infer, from whatever we know of the constitution of matter, that it, or its essential properties, can become nothing or be annihilated; it must follow, that it is equally impossible for reason either to discover or prove, that nothing can become matter, or in other words, that the materials of the universe were created. Reason is fully authorized to determine, that whatever bears in itself the marks of its own dissolution, has had a beginning; and the justice of this decision is confirmed by the mutability and decaying nature of millions of forms and modes of being; but as to the constituent materials of all forms, they carry all the marks of immutability that reason can desire to acquiesce in; and what appears to be immutable, yields expressly the same evidence of being eternal.

WE cannot carry our reasoning one step further, when we survey the great complex frame of nature, the heavens and the earth, than we are authorized to do in regard to the materials of which it is composed. If we suppose, with Sir *Isaac Newton*, that, along with its essential characters, matter is also possessed of absolute properties, such as the laws of motion, rest and resistance; and of relative ones, such as gravitation or attraction, cohesion, repulsion, &c. which are the basis of the constitution and powers of the whole; These, whether they are God, virtues gone out of Him, which adhere to whatever passes thro' his hand, or inseparably essential to the nature of material being, imply as little any symptom of their possibly decaying or being extinguished, as the above properties of matter which characterize it, and which I called essential.

FURTHER, all the vast and inexhaustible fountains and powers of universal life, which depend on each other, and correspond as cause and effect, bear as strong and reasonable marks of their permanent duration, as the materials employed in them do. Let some chimerical philosophers suppose and imagine as they please, reason has not one solid ground of presumption, that the sun will by length of time, waste and die out like a culinary fire, or that the stars of heaven will extinguish as dying lamps; that the vital air and liquid æther, which fill the expansion of the azure firmament, will pass away like the temporary
suf-

suffusion of a morning cloud ; that the solid earth will be resolved, cease to keep her course, or prove barren to the genial influences of the sun ; or that the waters of the ocean will in time be drunk up, like the dews of the night. No, all these, for ought we know, or can know, upon the strictest principles of reason, are as durable and immutable as time and space themselves : And whatever bears all the marks of eternity without end, must necessarily, to reason, imply expressly the same evidence of eternity without beginning.

As to the second argument, I shall only observe, that while it is impossible to determine the creation of the universe, either as to matter or form, by any philosophical argument, the most conspicuous footsteps of wisdom and design in the frame of nature can only suggest, That that vast mind, and that immense executive power in the world, must be coeval, and related together in some such manner as the powers of our body and mind are, so as to make one and the same being. This, tho' the fairest and highest conclusion that philosophy ancient or modern could ever attain, yields us no very respectable or reverential idea of that Infinite mind ; for however sublime views the stupendous grandeur of nature may give us of its abilities, the dispensations of fortune throw no light upon its moral agency.

Now I apprehend it is no unjust reproach
upon

upon the wisdom of such modern philosophers as profess, by the energy of their own capacity, to distinguish so clearly between nature and the author of it; that by constituting Him the immediate agent of what are called its universal Laws, they connect him as intimately with the world, as a soul can be supposed with its body: And truly, the philosophy which calls in the immediate agency of a Deity, as a necessary and essential part of nature, can never distinguish Him from nature; and as there are no traces of distributive justice to be found in nature, the lights of philosophy can never make such a perfection out in any being essentially connected with it.

IN a world of uncertainties, where good and evil, virtue and vice, harmony and confusion, happiness and misery, life and death, and all other contradictions, are undeniably blended together in an unconceivable perplexity; what can such grovelling, bewilder'd capacities as ours infer? The most natural and just reflection that can occur to such creatures, even after we are informed that these things are the result of Infinite goodness and wisdom, is, that they must be intentionally wrapt up in darkness, in order to confound all our impotent pretensions to penetration; and to reduce us to the mortifying necessity of confessing, That the author himself must give a key to his works, before we can conceive any meaning either in their structure or ends.

BUT,

BUT, not to insist further on the puerility and vanity of such philosophical theology, we shall dismiss the subject with one observation upon its necessary bad influence, in obstructing our further advancement and improvement in the knowledge of nature itself. How can enquiries into the powers and mechanism of nature be carried to any degree of perfection, under the direction of a system of philosophy, which sets out with muffling up our eyes with a codex of unmechanical laws of matter, presupposed as the basis of mechanism, instead of leading us to examine whether these themselves may not be the production of mechanism? Such are, The indifference in matter to continue itself either in rest or motion: Reaction being equal to action: The resistance in matter according to its quantity, to change of state: Gravitation, attraction general and elective, of a thousand kinds: Repulsion, elasticity, and its opposite, plasticity: Pressure of fluids in all directions: A fluid with no cohesion of parts, moving in diverging lines; its parts possessed of different degrees of attractability by other bodies, contrary to that law which makes gravitation simply as the quantities of matter: A fluid possessed of alternate fits of attraction and repulsion, &c. &c. To say no worse, it is very simple in philosophers to perceive, that the rearing and whole structure of the smallest fly, more marvellous than any of these, is carried on by mechanism; and yet not to presume that all these may be the result of mechanism also.

*Of Space, Dimension, and the Divisibility of
Matter in Infinitum.*

I CLASS these three together, because the two latter will serve to illustrate what is to be considered of the former. It is not without reason, that in the present philosophy, *space* is always considered in the first place; because without admitting space void of matter, the whole system falls to the ground of course.

THE necessary subserviency that such space is of to this philosophy, is a proof that it is founded upon principles as occult as these of the peripatetics, which are at present treated with so much derision. But, tho' some of the occult qualities of these ancient philosophers can now be explained, it is not handsome in the present philosophers to despise their ignorance, seeing they only acted the very same part then, these do now, of resolving these things into principles and laws which they could not account for.

BUT the present philosophers have really done worse, for they have actually assumed a principle, or rather a new-invented kind of being, called *empty space*, in order to render their occult principles consequentially necessary: For where nothing is between bodies, nothing to be sure can agitate or move them, but some insensible properties inseparable from their sensible ones. Now, tho' *Aristotle*, and his

numerous followers, supply'd their ignorance with terms of art, which stood for principles; yet they never assumed any previous maxim, which, while received, prevented any possibility of discovering whether their occult qualities were any thing else but what they called them.

THIS same infinite space is the most wonderful thing within the whole range of being; to enumerate its contrary definitions is impossible. It is neither God nor his creature; and yet it is inseparable from the being either of God or of any thing he can create. All matter is space, whatever more it is; for space is an essential property of matter, it is in space, and space is in it: Wherever matter is, there space is; and there space would be, tho' matter were not there. The same holds just as true, with relation to it and spirit, or it and God: It is infinite both in its extension and in its duration; it is immovable and indivisible. If a complete definition of it were put into a lady's pocket-book, I am persuaded there is not a woman that wears one, but would positively guess it to be an ænigma for NOTHING; and she would be astonished to be told that, in the judgment of the learned, it is the quintessence of a most learned, most metaphysical, and most subtle argument, maintained upon the subject of space by one of the most celebrated divines and philosophers that the last or any age has produced.

THE only positive idea applied to space, is *extension*; but we can apply no idea to any subject, which the subject itself does not impress. Matter forces upon our senses the idea or image of its dimension or extension. It is philosophical felony to steal an image which nature gives us, and invest a subject with it that never excited any idea in us, and consequently has no existence to us: We create *nothing* into a being, by applying ideas to it which we derive from *something*. Space is only one of the ideas excited by matter, and by the power of the mind abstracted from its subject, just as we can image a colour to ourselves, without connecting in our apprehension a subject with it wherein it exists: A little more of the same metaphysics which can prove that nothing is extended, will prove that space is purple. But why should I say purple? Space is of all colours, if light is reflected by vacuum and not by matter. It is a very ingenious contrivance in philosophers, to render *nothing* a subject of enquiry and conception, by dressing it in a suit of cloaths borrowed from *something*.

Now space, or extension, being certainly a necessary or essentially constituent property of matter, the philosophers affirm to us that matter is divisible in *in infinitum*, at the same time they have determined punctually, that space is absolutely indivisible: This favours rankly of contradiction. The more modest friends of this philosophy are willing to interpret the doctrine of the infinite divisibility
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of matter, not as an assertion of the actual possibility of dividing any parcel of matter without end, but as a mathematical possibility of conceiving its extension eternally divisible into lesser and lesser extensions. So far the concession is just; for what God created an unit, the nîsus of the whole creation upon it could not bruise or separate into two; indivisibility is one of its essential inherent properties. But then do they not still propose a palpable contradiction, by maintaining its dimension, or the space its surface measures is divisible infinitely, while they assert at the same time, that space is indivisible.

I LATELY saw a very pretty, tho' common and simple, experiment exhibited, relative to, and intended to illustrate, the common doctrine of space; which this is therefore a proper place to make a natural reflection upon. The experiment shewed, that by an image formed in the air, at a certain point of distance between the concave speculum and any person looking into it, extension and form became an object of sense, where there exists neither solidity nor sensible resistance. But that does not prove, that an image can be formed in empty space, or where there is no matter; unless we can prove first, that there can be no matter where we are not sensible of resistance. But on the contrary, I infer from that phænomenon, that these spaces, which in a loose and incorrect sense we call empty, are as full of matter as these in which the most solid bodies are: For as our senses
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can be affected only by matter, they are certain infallible standards for determining where matter is ; so that we may be as assured of a fullness of matter where we see any thing, tho' we cannot feel it, as we would be certain there was matter where we felt it, tho' we could not see it, or tho' it were the nature of that matter to be invisible ; as I presume would be the case with all solid atoms, tho' each were as big as a mill-stone : For it is owing to the interstices in bodies that they become visible.—All kinds of reflected images conspire, I apprehend, to prove, that as it is their property by means of light to affect our sense of seeing, so wherever an object can be formed to impress that sense, there must be as great a fullness of matter as in the original object, from whence the image was trajected to these spaces where it is again renewed.

THO' the infinite divisibility of any given extension may be easily perceived to be a metaphysical or mathematical sophism, as I must take the liberty to call the whole doctrine of infinites, especially as pretended to be canvassed by mighty finite capacities ; and tho' it is not easy to adduce a precise refutation of such unconceivable refinements, yet the Newtonian philosophy, by the relation it establishes between power and distance, in the doctrine of gravitation, has furnished us with the means of a direct disproof of this. For if the power of gravitation between bodies be as the squares of their distances ;
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and if at any given distance, (no matter whether we call it a yard or 100 thousand miles) the power of their tendency towards each other is equal to any given number; then at half that distance, the power will be four times as much, and so on. Hence it must follow, that if that distance is divisible into infinite parts, that power of attraction between them will increase infinitely beyond all calculation: But this is grossly false in fact; for we know when bodies come into actual contact, by means of this supposed power, their resistance to separation again, or tendency to unite, is very limited, and easily overcome by an excessively finite power. Therefore as at contact, which is the end of distance, the power of attraction is finite, of consequence the spaces they traverse before they meet cannot be infinitely divisible. And no demonstration, no not a mathematical one, can be true, which implies a flat contradiction.

Of the Properties of Matter.

AS Natural Philosophy is principally concerned with matter and its various conditions and powers, it is necessary, in order to attain a distinct idea of the subject, to class properly the properties or qualities assigned to matter; which fall naturally into three divisions. First, These properties which are essential, and without any of which we can have no idea of it: These also are three;

three ; 1st, Solidity perfect and impenetrable, and consequently indivisible : One atom may be divided from another, but no atom can be divided from itself, because (however mathematicians may quibble about the divisibility of its extension) its substance does not exist by cohesion of parts, or application of one substance to another, but exists in an original continuity of substance, which is undissolveable and unchangeable but by annihilation. In short, an unit of nature is not composed of an infinite number of mathematical points, cohering by gravitation, attraction, or any power a name can be invented for.— Why? because a mathematical point is as much nothing as an infinite space is, and therefore the most infinite number of them will never make one atom of matter. 2^d, Whatever is material, must have size or extension, and yet that dimension of the largest ultimate particle of matter, is in all probability incomparably smaller than any mathematical point that the philosophers can either form any distinct idea of, or than they can have any real occasion subservient to human researches into nature to suppose. 3^d, Whatever is material, must have figure or shape : If that were not the property of every the smallest unit of matter, any collection of them could not acquire that property by combination or cohesion. These three are so essential to matter, that they may with strict propriety be called the characters of materiality, being each of them inseparable from any possible conception human creatures can
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attain of the ultimate parts of the material universe.

BESIDES these characteristics of materiality, there are two other kinds of properties assigned to matter, which belong not to its essence, but to its motions or the conditions natural to it; one kind of these properties may be called,—Secondly, *Absolute*, because they are considered as belonging to every part of matter separately, without any relation to, or connexion with, other parts of matter: These are three also, and are assumed as axioms in the present philosophy, called the laws of motion. 1st, Matter is indifferent to continuance in rest or motion, or rather it has a tendency by which it continues itself in which-ever of these states it is once put into: This is called the *vis inertiae* of matter. 2^d, Every alteration in the state of any body from motion to rest, from rest to motion, or from one degree of motion to another, is in proportion to the quantity, and in the direction, of the power applied to stop or move it. 3^d, When matter is put into motion, it communicates just as much resistance towards stopping or weakening the motion of the body employed to move it, as it receives motion from it: And reversely, when moving matter is stopped or retarded, it communicates just as much power towards moving the body which stops or retards it, as it loses in its own motion. To make these three laws fully understood, and liable to no mistake, it will be necessary to give a definition of what is meant by

by the term *quantity of motion*, which the less skilled in such terms may be apt to mistake for the velocity of motion : And the application of this definition may, without impropriety, be called a 4th law. The quantity of rest or motion in any body, is in proportion to the quantity of matter in the body ; and the resistance it gives to the powers applied to move or stop it, is in the same proportion. Thus, a body of five pounds weight has five times the quantity of motion that a body of one pound weight, moving with the same velocity, has ; and by the like proportions are all the circumstances of motion, rest, and resistance to be estimated.

Thirdly, T H E third class of material properties ought to be distinguished by the name of *relative* ones, because they are supposed to depend upon some mutual influence which the different parts of matter have upon each other. These are gravitation, attraction, repulsion, and if there be any others which we have yet no names for. Attraction, whether it be a distinct principle from gravitation, or only a modification of that general principle, may be distinguished into *general*, which is the common principle of all cohesion ; and *elective*, such as the affection between the loadstone and iron, oil and oil, water and water, in opposition to oil and water, &c. It may also be distinguished into *permanent*, such as the power of the loadstone ; and *occasional*, such as electricity, which only

acts sensibly when mechanically excited!
 —Repulsion is subject to the same divisions.

Of the VIS INERTIAE.

Matter is indifferent to continue in Motion or in Rest. A Body in Rest will rest for ever, unless disturbed by some Impulse; and if in Motion, will move for ever, unless resisted or stopped.

UPON this proposition I offer the following thoughts. Rest and motion are the two greatest opposites in nature. As opposite they are as good and evil in morals; more opposite than light and darkness, because all the darkness we know is only comparative and not absolute; nay, as opposite as matter and nothing. The mind cannot be struck with a more palpable contradiction. by affirming, that a body is equally disposed to blackness and whiteness, or hardness and softness at the same time, than is felt upon saying a body is equally disposed to rest or motion. Motion and rest are not only two opposites, as there are many, but they are the fundamental ones upon which all the oppositions in nature are founded.

MOTION is a positive, which implies action, change of place, power or force wherever it acts. Rest is a mere negative, in which state body is divested of every one of these; it exerts no natural power, it weighs, acts, or presses

presses neither backward nor forward, up nor down: It produces no effect, and therefore is in the exercise of no power. A body which rests mechanically, being ballanced in its place by opposite powers (however subtile and insensible) pressing it equally, will, and must exert resistance according to the degrees of motion another power forces it into; but that which rests by no power acting upon it, can have no power in itself; for all the definition we can give of natural power is, That it is matter either actually moving, or exerting a nîsus to motion, as a suspended weight does. But there cannot be conceived any power to reside, where there is no tendency to action. The same body cannot be indifferent to the exerting of actual power, and to the exerting of none, at the same time.

AGAIN, it is impossible that rest and motion can be equally indifferent to matter; for if matter was created, the Creator might be supposed to say, let it be, without adding any act of volition, determining in which of these states it should commence being. Now in this case, it could not come forth both moving and resting. One only of these conditions it could possibly assume, and must have remained in for ever, unless some further divine energy had given it a new determination. Now, which ever of the two conditions the common sense of mankind will admit matter would take existence in, that must be called its natural state; and every alteration of that state, must be the effect of some

some power superinduced upon it, which must cease when the cause ceases.

AGAIN, it is allowed matter may exist in rest, but matter in rest is not life. All life in nature, whether mineral, animal, or vegetable, and whatever characterises matter to our senses, depends upon motion, activity, and power in matter: Therefore motion seems to be not a natural condition of matter, but superadded, and constantly supported to constitute life, variety, and mutability. If this is not so, then upon the principles of the present philosophy the doctrine of the *Epicurean* philosophy, for ought we know, may be true; for if motion is as indifferent to matter as rest, we know not but the atoms of matter either moved eternally, or moved since ever they existed; and all that is supposed to arise out of the fortuitous concurrence of atoms may be true, if their first principle, that self-motion is as natural to matter as rest, be admitted: For whatever is equally indifferent to matter is equally natural to it, and if motion is natural to matter, all the consequences of it may accidentally become so too.

FURTHER, it is evident that all known material motion proceeds upon, and is regulated by mechanical laws, both in its direction and impetus; and, I apprehend, motion, uniformly conducted by the laws of mechanism, seems naturally to imply a constant mechanical cause. If this mechanical system is traceable in most cases, and in by far the
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most subtile and elaborate works of nature, such as plants and animals, why may not the same heavens which influence, rule, and move every thing upon the earth, rule the motions of the earth itself, and impress all matter with these general tendencies; which being unalterable, are the basis of all human mechanics. I think it is doing honour to mechanics (that truly valuable and curious branch of natural philosophy) to suppose, that the course of nature is framed and conducted upon its principles. Neither I hope is it offering any dishonour to the Author of nature, to presume He is so great a mechanic, as to be able to construct this vast engine of nature, this immense theatre of life, beauty, and variety, so perfectly and unerringly, that it shall execute all his intentions without the necessity of the workman's hand always at it in order to keep it going.

ADD to all these considerations, that the quantity and conditions of inconceivably the largest proportion of matter in the universe, seems to be such as implies its mechanism and powers every where. Every naturalist knows with what prodigious force the air acts upon any place where it is excluded: There is a perfect torricellian exclusion of elastic air, it will be allowed, in the space occupied by a cannon ball, or any other dense body: It is impossible then that it can be constantly changing its place with any, even the highest, degree of velocity, but it must be as constantly pressed upon behind, in the direction

rection of its motion, with all the power and force that air presses into a vacuum. This must certainly have great influence, tho' totally overlooked by our philosophers, in the propagation of all motions we are conversant in.

BESIDES, this rare, fine-spun body *light*, as the present philosophy represents it, furnishes the most obvious and incontestible proof of its being the most dense and omnipresent of all bodies. For, not to carry my reader out of the room, where he may be perusing this paper, for a proof of it, let him only consider what his sense teaches him, and what the present philosophy admits, tho' it seems never to have regarded the conclusion which must follow upon it. There is not one visible point in the room which does not emit perfect continuous lines or rays of light to the eye in all directions: If all the room were eye but one visible point, all the eye would see it in every point. It is very true, the philosophers may call these diverging rays, because the point may be considered as a centre, and the room as a circumference; but when we consider that there is not a point in the circumference where this point as a centre is not visible, one would think that this very consideration would go well nigh proving a fullness of the matter, as well as of the form of light in the room. But when the conditions of light, with regard to one single point of the room, proves so much, what shall we say when we consider the room as a continuation

ation of an inconceivable number of such visible points? Every one of which is visible in every other point, or every one of which implies in its conditions the proofs of a plenum: Rays diverging from every point, and rays converging to every point without exception. Can human understanding or conception form an idea of such a thing, without necessarily falling under the conviction of a plenum, from these two opposite circumstances, of all visible objects within that compass of each other, to the extent of all that the eye can in any place comprehend of heaven and earth. This is the most conclusive experimental philosophy, without the assistance of one instrument, as to this matter. But how philosophers came to know what would be the circumstances of motion where there was no matter, save the body supposed to be moved, is beyond the compass of my reflection; and it is no less unconceivable how motion can be carried on in such a medium, without the medium being concerned in it.

Of the SECOND LAW OF MOTION.

Every Alteration in the State of Body, from Rest to Motion, or from Motion to Rest, is in Proportion to the Quantity, and in the Direction, of the Power apply'd to move or stop it.

WE have, we can have, no other idea of power, but that it is matter in motion or exerting a nifus to motion. All power being resolvable into a tendency to motion,

motion, it is impossible to connect the idea of power to matter at rest, unless that rest be the effect of power fixing it in its place, which may properly be termed *mechanical* rest. This rest being the effect of power, will exert a *nisus* or resistance to motion, when it is acted upon or pressed to change its state. But matter in an uninformed state, unconnected with all sympathy or mechanism, unacted and unacted upon, can have no power in itself, can exert none, because power consists in motion, or a *nisus* to it. The only idea we can have of a *nisus* to rest is, a tendency to motion, ballanced by resistance; because tendency to action is necessarily implied in the term *nisus*. Therefore matter resting unmechanically, that is, without any cause, can have no *nisus* in itself, else it would begin motion thereby, and continue it while that *nisus* remained in it. An unmechanical *nisus* in matter to rest is, in other words, an active power exerted by it to do nothing, or to keep itself from doing something; and to suppose that matter in rest exerts any virtue or power to preserve itself in that state, is supposing, that without that virtue it would fall into motion.

THE states then of motion or rest being the result of absolute passiveness in matter to either; and the effect of no positive *nisus* towards them; therefore in an unmechanical state, matter can exert no resistance to change that state, and of consequence, an atom of matter would have as much power in moving
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matter the size of a planet, as the latter would have in moving the former, as neither of them can possibly have either resistance to motion, or tendency to it, longer than they are moved by some power acting upon them.

As action, or energy towards action, is inseparable from the idea of a nifus to anystate; and as a nifus to passiveness is a contradiction in terms, it is rational to conclude, that the principles and properties of power or motion cannot be looked for in matter considered abstractly, but in the organisation or systematic structure of it. Therefore, tho' it must be allowed that the changes of state in matter, are proportioned to the powers which produce them, yet it is impossible to conceive that the power shall continue in the body acted upon, after the exterior power ceases to act upon it; or that bodies have an innate faculty of changing virtues or nifusses with each other every time there is a collision between them. Shall we be told, and will any rational person believe upon the word of a philosopher, that a body at rest has a nifus to rest, which yet does not prevent its moving whenever it is struck; but when it is struck, the nifus to motion leaves the body striking, and passes into the body struck, while the nifus to rest departs from the body struck, and enters into the body which struck it. Can this incomprehensible chimera gain credit with rational enquirers into nature,

It is not only impossible to separate the
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notion of power from that of material action, which is *motion*, but it is also impossible to separate the idea of power from that of *resistance*. We can form no conception of power nor proportion of quantity in it, but comparatively, by some resistance it is conceived to overcome, or be matched with. There is resistance overcome in the very action of power, tho' its efforts are directed against no sensible object. In brandishing the arm or a weapon, or in the working of any engine, tho' not applied to produce any effect, there is a constant resistance overcome of the weight, &c. of the body so moving; and abstract these from the motion of the body, we will find that all our ideas of motion will vanish, and also all conception of any effect, that can possibly be produced; for if these properties in any moving power, which imply a re-nisus to its motion, were abstracted, we can have no notion of the motions producing any effect; because the momentum of motion or power, lies in that very property of the moving body, which gives it at first a proper, felt resistance to any given sensible quantity of power applied to move it,

Of the THIRD AXIOM or LAW OF MOTION.

When Matter is put into Motion, it communicates just as much Resistance towards stopping or weakening the Motion of the Body employed to move it, as it receives Motion from it.

THE present philosophy would perhaps think this law more properly expressed in the following terms: When one body acts upon another, the action of that body upon the other is equalled by the contrary re-action of that other body upon the first. The philosophical wording of the most common phenomenon should be carefully examined and attended to, for sometimes it means something very different from the idea that the phenomenon itself suggests to our senses. It requires a good deal of philosophical address in the use of words, to explain, for example, the appearance of resistance which one body meets with when it moves or strikes against another, into terms which are intended to convey a philosophical idea distinct from proper resistance; tho' all the circumstances which attend such a phenomenon are individually and undistinguishably the same as are produced by proper resistance. If one pushes his finger forcibly against a stone or any hard body suspended, a cautious circumspect writer will not say the finger is hurt by the resistance it met with; but he will chuse to express it rather thus, the finger being a sensible soft body, the parts which come first into contact with the stone have their motion

retarded, while the other parts will be advancing forward with their original violence. But certainly this definition of the matter, however learned, must seem very simple when one asks this plain question: Does not this very same thing in all its circumstances happen, when the finger is pushed with violence where it meets with proper resistance? It is a maxim in sound philosophy, that like causes produce, under the same circumstances, like effects; and consequently, similar effects imply like causes. It is impossible for me to comprehend, why the present philosophy, in its very postulata or first axioms, should fly in the face of this rule of reasoning, without holding to which, reason has absolutely no standard for investigating any operation of nature, which is not the palpable object of sense. It seems as if at first starting, it were proposed not to enquire if there was any insensible mechanism in nature, and how far it could be traced, but to exert the utmost sophistry in order to disprove and reject it. The philosophy seems to have assumed a vacuum, empty space, as its idol and first necessary principle, and we must not trust our senses, or any argument drawn from sensible powers which threatens to interfere with it.

IF this was not the case, what other need could there possibly be for defining all the signs of proper resistance by any other than its own proper name, *resistance*? There are all the signs of positive resistance to be perceived in matter, whether moving or resting,

ing, in this natural state in which it is exhibited to our senses and examination. Resistance implies power (as I shall shew immediately) which is nothing else but either a *nîsus* to motion, or an effort to restrain from motion. To assert any proper powers or virtues in matter, would be to maintain the doctrine of occult qualities, which are exploded; therefore it seems to be thought necessary to disguise these manifest appearances of power in matter under ambiguous terms; where a fact, a positive, is defined under phrases which convey only a negative to the mind, or which convey no idea at all.

VIS INERTIÆ is the general term the philosophers have agreed upon, to express the doctrine contained in these assumed primary axioms of mathematical philosophy. They themselves are discontented with the word *vis*, as too explicitly expressing what they would not be understood to say; and therefore they joined *inertiæ* to it, as physicians compound acids and alkalis; in order to destroy the meaning of *vis*, and neutralise the expression, so that it may be understood to mean neither a positive nor a negative. But to decide the point as to this third axiom:

I S A I D I would undertake to shew, that this law was regulated by, and entirely depended upon, proper power; *power* so acknowledged by the present philosophers themselves. They never had it in their power to make the experiments or observations, on which they

they establish this axiom, upon any bodies but such as were under the influence of gravitation; and if this axiom can be demonstrated to depend upon gravitation, whether we conceive it a law or a mechanical power, then it must cease to be an axiom, as being only a secondary accident or circumstance depending upon another avowed cause.

THAT the nifus of gravitation, mechanical or not, no matter at present, is a proper power none will doubt, unless they take upon them to dispute whether there is such a thing in nature as power. Power is, and can be nothing else, than a nifus to material action, which is motion. Resistance or re-action must be produced wherever matter in motion encounters matter either moving, or having a constant tendency to move, in an opposite direction; or in any direction which deviates from that in which it is struck or impelled by another power. To pass here the power of cohesion, by which the parts of bodies are powerfully determined to press inwardly upon one another, in what may be called a centrical direction; all bodies have a tendency to gravitate downward or toward the earth, therefore this tendency must react or resist, according to its quantity, upon every power applied to move a gravitating body in any other direction.

THE philosophers say, that matter reacts according to its quantity of matter: But, what is surprising, they seem never to have
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considered that we have no mean of estimating the quantity of fixed matter contained in any bodies, but by that quantity of gravitation, or unvariable power, tending always to move in a prone direction, or downward: Hence we must necessarily infer, that the law of reaction is not according to the quantity of matter, in particular detached parcels thereof, but according to the power of gravity acting between them and the earth; for let us suppose, that the gravity between the earth and any body were one half less than it is, it would follow, that that body would have but one half the reaction that it now possesses; and of course, if that gravitation were altogether substracted, or suspended, then it would exert no reaction at all, and the axiom becomes totally false.

LET us take the case in a reverse light; it is supposed, that the power of gravitation is 23 times greater upon the surface of the sun than it is upon the surface of the earth; hence a body which weighs one stone here, would there weigh 24 stone, and consequently would re-act 23 times more than it does here, without any additional quantity of fixed matter in it: Therefore this reaction assumed as an absolute law inherent in matter, distinct from, and independent of its other characters and properties, is only a circumstance which depends upon the relative law of gravitation: The matter scarcely needs any further illustration, but as a decisive one occurs I shall state it. Suppose a pound of iron is attracted
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by a loadstone, with a power equal to the weight of three pounds more, it would follow in fact, that that pound of iron, under this state of attraction, would resist motion, or react upon any body striking against it, as if it contained four times the quantity of matter it really does contain.

T H E R E F O R E, upon the whole it follows, that two fundamental doctrines of the present philosophy must be false. 1st, The doctrine of reaction can be no axiom, nor primary law, but only a necessary consequence of gravitation. 2^{dly}, The law of gravitation, as stated by the philosophers, is no decisive proof of the quantity of fixed matter in bodies; since the influence of the loadstone will encrease the weight of iron, or its resistance to any given impulse applied to move it, without encreasing its quantity of matter.

*Of the Centripetal and Centrifugal Forces;
Or, of the joint Influence of Gravitation and
Projection, in producing the Revolutions of
the Planets.*

First, *From the defined Nature of these two Powers, it is impossible they can produce such an Effect.*

I N another age, if not in this, it will be looked upon as a subject of universal wonder, if not deemed incredible, that one of the most profound mathematicians in the world should

should assume two powers for circulating the planets, and esteem them so certain as to undertake to estimate the very quantities of matter in the celestial orbs, by the most intricate and elaborate calculations, made upon the supposed relations of these powers to one another, and the proportions in which they must act in producing and maintaining the circuits of the moving stars; while it is demonstrable to common sense, from the admitted nature of these two powers, that it is absolutely impossible that they can support one single rotation of any orb, in any of the areas they are said to describe.

GRAVITATION is allowed by all to be a constant power inherent, or acting in bodies, which cannot be suspended nor altered, but by change of distance between the bodies mutually so affecting each other. It cannot be suspended, for tho' its tendency may be resisted, yet all its misus to that tendency remains invariably exerting itself, or pressing towards it. It is therefore a proper, undestroyable power, uninterruptedly acting in or upon bodies.

THE characters given to *projection*, as a power, are expressly the reverse in every respect. When in motion, it is said to have no proper resistance to change of state, whereas gravitation, even when bodies are at rest, reacts and exerts a misus to move. When any proportion of the quantity of projectile motion is destroyed, either by direct opposition, or by

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oblique alteration of the direction of its progress, projection acts as no nifus to recover the original quantity of motion it was projected with; consequently, as long as any power, such as gravitation, is constantly concurring to bend the direction of projection, it must be constantly esteemed as so much continued resistance to the power of projection; and projection constantly sustaining, by that degree of resistance, a diminution of its momentum, or quantity of motion, which by the acknowledged properties of that power it has no nifus ever to recover, the smallest continued resistance which is able either to retard its motion, or vary continually its direction, will at last exhaust its power, tho' originally never so great, and leave the body at last solely to the influence of that power which has acted as resistance to its projectile motion. This is the case with every projectile on the earth, however superiour the projectile force may be in any body at setting out, yet it is soon weakened by the gravitating power, and is retarded till it comes to rest in the direction of a parabolic curve.

THE great Sir *Isaac Newton* has admitted somewhere, that these two powers of projection and gravitation, may be supposed to be so regulated that their direction may describe such a curve figure, that any line drawn from the centre to the area of motion, will every where fall upon it at the same angle. By this figure, I suppose, he must mean a spiral one; for I know of no curve to which that proper-

ty will apply, save that of a perfect circle; and a spiral curve. But he has no where, that I know, reflected upon this circumstance of the two powers of gravitation and projection; that the one retains its whole misus to motion, whether it be retarded or stop'd, while the other altogether loses as much power as it meets with opposition; neither, in his ballancing these powers, does he seem to have reflected upon one of the most obvious truths in geometry, that every alteration in the direction of the motion of a projectile, is equivalent to a proportionable destruction of the momentum of of its motion, which cannot be repaired without supposing that projection is not a first impulse, but a continued action of the primary moving cause, not ballancing gravitation by the laws of projectile motion, but by his own constant agency.

A SELF-CONTRADICTION being implied in supposing bodies can act where they are not; and philosophy having certainly pronounced, that there can be no self-motion where there is not an immaterial principle inherent in bodies; because of these two maxims, the doctrine of gravitation and attraction laboured under all the ignominy of the reprobated hypothesis of occult qualities; until some ingenious friends of the present philosophy resolved that doctrine into the immediate agency of the Deity. If the impossibility of supporting the original power of projection, while it sustains a constant resistance from gravitation perpetually bending and altering its

its direction, shall reduce the present philosophers to explain the perpetuity of projectile motion, tho' labouring against a continual resistance, into the constant agency of a first cause also, then the whole philosophy, name and thing, falls to the ground at once. For every one must acknowledge, that without any respect to these two nominal powers, it is more easy for the Deity to move the planets round in any kind of curve he pleases, than it is for a man to make a ball in his hand describe a circular motion.

PHILOSOPHERS have illustrated to us the joint effect of centripetal and centrifugal motion in making bodies move in a circle, by the simple experiment of casting round a weight suspended by a string in one's hand: But this illustration, tho' plausible, contains a very palpable deception. For the power of the string restraining the body from flying off in a tangent, bears no analogy to a power actually drawing the moving body towards its centre of motion. The string resists its flying off, but it has not the least tendency to draw it nearer: And truly, if ever the philosophers discover the genuine cause of the revolutions of the planets; I mean that power which regulates their direction, I will venture to determine *a priori*, that it must be some power which simply resists their receding into eccentric motions; for it cannot in the nature of things, be one which is either drawing or pushing them uniformly into their centre of motion.

Second, Of the Impossibility there is that the Powers of Gravitation and Projection, can move the Planets in these Orbits, in which astronomical Observation has discovered they move.

LET us now suppose, what the present philosophy (tho' essentially necessary to that system) does not assume, but on the contrary denies in its very first principles; That, namely, the powers of gravitation and projection, are endowed with the same positive properties of still retaining their original nîsus to their respective motions, however they may be retarded by counteracting each others directions; by which means the rotatory motions of the aerial orbs are preserved: Yet allowing this, it is impossible that these two powers, acting by immutable laws, can move any orb in any other area save that of a circle; whereas all the planets are allowed by the philosophers themselves to describe ellipsis.

THES E powers moving an orb in the figure of an elipsis, must no less than four times vary the proportions of their respective impulses, during the period of every complete revolution. The power of gravitation is uniformly gaining upon the power of projection, in the motion of a planet, from the higher apsis of the ellipsis in which it moves, until it comes to the lower. I ask not how the projectile force recovers itself at all again (seeing it is none of the properties of that power to recover the motion

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tion it has lost, tho' the counteraction to it should cease) but supposing projection in that respect, of the same nature with gravitation; I ask, by what law between these two moving causes, does gravitation remit the strength it has gained in bringing the orb from the higher apsis to the lower, and at that point allow projection to recover again the momentum it has lost, in order to carry the orb back again from the lower to the higher apsis of the ellipsis? In like manner, seeing projection has been gaining upon gravitation all the way to that point, how comes it all at once to lose its superiour momentum there, and how comes gravitation immediately to begin to preponderate, in order to bring the orb back to the lower apsis again?

I do not know a more gross misapplication of geometry, in the mathematical philosophy, than the reasoning they satisfy themselves, and impose upon others with, in that point, by referring the properties of a figure to powers of motion, which have not power to describe the figure. I grant it, it is true, that at these points where a radius drawn from the focus falls at right angles upon the tangent at the point of contact, there the figure begins to turn from the lower apsis towards the higher, or *vice versa*; but is that any reason why the powers of projection and gravitation should be sufficient to cause any orb describe such a figure? But say they, the planets do describe these figures, and we know of no other power concerned in their motions, besides

besides these powers of gravitation and projection, which we sensibly know all bodies are under the influence of. I answer, if the planets do describe areas which the laws ascribed to gravitation and projection are not sufficient to execute, it is a proof, either that these powers are not concerned in revolving the planets, or that they have a secret intelligence between themselves in exchanging their momentums occasionally, which contradicts the known laws ascribed to these powers.

It cannot be argued, that the increased velocity which brings a planet to the lower, contributes to carry it out again to the higher apsis, for that increased velocity was not the effect of projection but gravitation; therefore the orb can never get outward again, unless at that point gravitation all at once weakens its pull of the planet inward.

This leads me to examine that very pretty and ingenious (I must call it) tho' fallacious experiment, which represents the motions of the planets and the alledged powers which maintain them, by a ball suspended by a string, brought to the verge of a circle formed round its point of rest, and there struck in the direction of a tangent, with a force either equal or superior to the radius of the circle; by which means the ball will describe either nearly a circle, or an ellipsis. It is allowed that the ball brought to the verge of such a circle round its lowest point of suspension, and left to itself, will tend

to that point; it is also acknowledged, that the ball struck in any direction besides that of its tendency, will describe nearly a circle in one case, and in all others a kind of an ellipsis. If it is struck in the direction of a tangent, with a force superiour to its tendency, it will describe an ellipsis, whose conjugates coincide with the verges of the circle it is struck from; if with a force weaker than its tendency, it will describe an ellipsis, whose transverse diameters coincide with the verge of the circle; if it is struck in any direction, save that of a tangent, with a force superiour to the radius of the circle, it will describe an ellipsis that cuts the circle four times, the conjugates being within the circle, and the areas of the transverse diameters without it.

AFTER all this, it remains to be demonstrated, that in the motion of this ball, there is a cause concerned which takes no place in the supposed causes of planetary motion; and also that the elliptical figures described by the ball, differ essentially from these described by the planets: If this is the case, the experiment can neither be any illustration, nor any explanation of their motions and the causes of them.

IN the first place then, the ball in the experiment is suspended by the string, so that it is restrained from descending in the direction of its centripetal force beyond a certain point in space, namely, the lowest, to which it descends by the determinate length of the string;

string; so that when the ball is at rest, and no projectile power acting upon it, there is a re-action to its gravity acting upon it, and preventing its pursuing its own centripetal nifus. This restraining power is the cause of all the peculiar phenomena of its motions; but the planets are supposed to have no such restraint upon their centripetal tendency, which would of itself, without the interposition of projection, prevent their tumbling into their centre of attraction in a direct course. But verily, as I have already alledged without discovering a third power, which both resists their centripetal force, and binds in the projectile one, as a bowl does a ball rolling up and down in it, or as the string does the ball in the case under consideration, these two powers will never be demonstrated sufficient of themselves to perform one planetary revolution.

IN consequence of this third restraining power of the string, by which the ball hangs, the first phenomenon which depends on it is, that whenever the ball is acting at the string's length, and in any direction, except the perpendicular, it cannot attain its lowest point of suspension where its gravity will rest, save by vibrating to it in the direction of a curve, or in the segment of a circle. This would not be the case with a planet if projection were suspended, it would rush to its centre in a direct line at any given point of its course, being no where either higher nor lower than the point it would tend to,

A G A I N, it is solely owing to the third power in the case of the experiment, that all the elipses it can describe are spherical ones; such ellipsis, I mean, as one described in the inside of the bottom of a bowl, or spherical vessel, would be, where the transverse diameters are highest as well as farthest removed from the centre of the figure. This is a circumstance which never was ascribed to the areas of the planetary ellipsis, therefore the illustration is not adequate to, and so cannot be explanatory of, what it is adduced to explain.

L A S T L Y, from attending to the above peculiarity in the figure of the ellipsis, which the ball describes, we see an evident reason for the acceleration and retardation of the motion to and from the conjugates; because there is an ascending and descending in this case, which cannot be applied to the planetary ellipsis, unless along with gravitation we allow them a suspension of their gravitation, equivalent to the string or third power in the case of the ball; and that they must have before they can move in the figures they describe. When that is acknowledged, it will be then time enough to enquire, whether, allowing all friction and resistance of mediums to be removed, both the ball and planets would not gradually decline in their figures to their lowest point of suspension, and so come at last to rest.

T H E R E is however, one pretty, obvious,
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and certain like-inference, which seems naturally to offer itself, upon the circumstances of motion and figures described by the ball in this experiment; which the mathematicians ought to consider well and examine: It is this, that no figure can be conceived to be described by gravitation and projection round the centre of gravity, where that centre of gravity shall not always be found in the centre of the figure; whether it is a circle or an ellipsis. This however, is contrary to all astronomical observation upon the motion of the planets, which has determined their centre of gravity to be always in one of the foci of their elliptical orbits.

Thirdly, Of the mathematical Proportion required between the Powers of Gravitation and Projection, in order to the circulating of the Planets round their Centre of Gravity.

THE disproportion is here so glaring and irreconcilable with all the plainest rules of geometry, that I am almost ashamed to suppose, it has escaped the observation of the most profound mathematicians; and if it has not, I am absolutely at a loss to account for their silence upon it.

As a primary illustration and demonstration of the joint effect of projection and gravitation in circulating the planets, it is always proved, that a body impelled in different directions, by two powers at the same time,

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will describe the diagonal of the parallelogram of these two powers: From which arises two self-evident corollaries. *1st*, In the same proportion that any two powers cause the impelled body decline from the direction of their different impulses, in a like proportion do they destroy the effect of each other's powers upon the impelled body: Or, in other words, as the angles are which the diagonal makes with the sides of the parallelogram, so will the length of the diagonal be to the lengths of the two sides. *2^{dly}*, In that proportion in which the one power exceeds the other, in a parallel proportion will the direction of the diagonal approach nearer to the direction of the greater power; or, as the lengths of the sides of the parallelogram are in proportion to one another, so will the largeness of the angle be, which the diagonal makes with the shorter side of the parallelogram, and the acuteness of the angle which it forms with the longer side.

FROM the relation then that the diagonal bears to its parallelogram, it must follow, that in order to move a planet or any body in a circle, or nearly in one, it is required that the moving powers be equal or nearly so. The proportion of the moving powers to one another, can only be determined upon one and the same body or planet, by the velocity of the respective motions with which the moving powers do impress it. By the velocity of the motions, I say, for tho' the quantity of the motion in different bodies must be determined

terminated by the quantity of matter moving, and the velocities taken together, yet in one and the same body, the quantities of its motion must be determined solely by the velocities of that body's motions.

Now equal powers must be necessary to move any body in a circle. Equal powers can only be determined by the equal quantities of motion they produce; but in the case of the powers of gravitation and projection, which are supposed to conduct the earth's revolution, the proportion between them, as ascertained by the ablest mathematicians and most strenuous supporters of the present philosophical system, is so far from being equal, that the immense disparity between them can scarcely be reduced to calculation.

If the sun and the earth were as near each other as the earth and the moon are, and were left to the power of their mutual attraction, they would move towards each other with the same velocity, as it is supposed the earth and the moon would do, which is, I think, about 16 feet in a minute. It is true, their quantity of motion would be vastly greater, because their quantity of matter is so, but still by the laws of gravitation, their gravitating velocities would be parallel to these of the earth and moon; excepting so far as the proportion of matter in the earth to that in the sun, differs from that of the moon to the earth. If then the earth at that distance from the sun, which the moon

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is from the earth, would gravitate towards him with the velocity of 16 feet in a minute; and if the decrease of gravitation be inversely as the squares of the distances, that is, at double the distance, four times less; and at thrice the distance, nine times less; then the earth being immensely more distant from the sun than the moon is from the earth, the velocity with which the earth at her present distance from the sun would move towards him, if left to the power of attraction, must be immensely less than that of 16 feet in a minute. But what is the momentum of 16 feet in a minute, or even a thousand times that, to the momentum of projection; which is said to impel the earth at nearly the rate of a thousand miles in a minute?

IT is evident in mathematics, that the diagonal of a square makes an equal angle with both the sides; and this is used as a demonstration, that it requires equal powers, or forces which act with equal momenta, to incline any planet's motion into the direction of a circle. But if we find two powers condescended upon for effecting this, whose momenta bear not the proportion to each other of one to 10,000; these powers cannot be represented by the two sides of a square, but by the sides of a parallelogram, the length of whose shorter side bears not to the longer, the proportion of one to 10,000. It is further evident, from the second corollary above-mentioned, how nearly the diagonal of such a figure will approach to the direction of the longer

longer side; and if such a diagonal is supposed bent into a curve by the power represented by the shorter side, it is evident that curve would form no part or segment of a circle or ellipsis, but of an eccentric curve, which would hurry the orb farther and farther from, and so fast diminish and totally exhaust, the weak influence which the smaller power had upon it. In short, if the power of gravitation impels or draws the earth towards its centre of gravity, with the momentum of an inch, a foot, sixteen feet, or 1600 feet in a minute (it does not signify which) while the power of projection impresses it with the momentum of almost 1000 miles in the same time, it is impossible for mathematics to demonstrate, that an orb hurried off by such a projection, where there is such an inconceivably small and disproportionate a resistance, can ever be recalled again from its eccentric motion; especially as the power of gravitation, inconsiderable as it is, must be growing weaker every minute, nay every second of its motion. Nor can the mathematical properties of an ellipsis, or of any figure, ever prove that gravitation, which it is momentarily wasting and spinning out to a cobweb thread, will at any point recover a superiority to the projectile momentum, and grow at last a cable, massy and powerful enough, to bring home the wandering star again.

SOME may apprehend the force of the above objection sufficiently obviated and removed, by the resolution of the powers of
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gravitation and projection into the mathematical relation of the proportion which an arc bears to its versed sine, and by telling us these powers must be equal, if it is found that gravitation would move a planet left to its power, the length of the versed sine towards its centre of gravity, in the very same time that projection does carry it thro' that arc which corresponds with the versed sine.

BUT I have shewn already, in relation to elliptical figures, how fallacious it is to reason from the properties and relations of figures, to the supposed powers of motion, and it is no less evident here: For the accelerated motion of a gravitating body, thro' any given space, cannot be attributed to the power of gravity solely: The whole acceleration, it must be allowed by all, is maintained by the *vis inertiae*, or tendency in matter, to preserve every quantity of motion it momentarily derives from gravity. If the moon were allowed to begin at the distance of 300 feet to fall towards the earth, she would not descend by the force of gravity so fast as a stone does from the same height: Therefore the immense acceleration she would acquire in descending from her present distance, must be referred not to the power of gravity, but to the second axiom of the present philosophy; and it is a gross fallacy, to engross that law to eke out the momentum of gravity, in order to ballance it with the projection of the planets. So that in fact, if the real quantity of power of motion, excited by gravity itself, were

were to be analyzed by the doctrine of fluxions, which certainly the mathematicians will not refuse to do, it would be found a mere evanescent quantity, which imagination itself could not possibly bring into any conceivable commensuration, with such a positive and immense power, as that of projection is allowed to be in the case of the planetary motions.

BUT to give the argument for gravitation as much advantage as possible, I have in my reasoning above, considered gravitation as a positive power, in which case, I say over again, that the powers must be equal which incline any body into a motion, whose direction lies equally between the directions of the two powers.

FOR further proof of this, if it is necessary, let us examine gravitation by comparing it with the only power, tho' merely a resisting one, it can be exemplify'd by, namely, the string by which a ball hangs while by projection it moves in a circle. No line can sustain the momentum of a body moving round, but what is at least able to sustain the weight of that body at rest. Therefore, the positive momentum of gravitation must be as great as that of projection, which it cannot be, unless their velocities are equal when their powers act separately. It would be a mere evasion to alledge, that the gravity or real weight of the earth at our distance from the sun, is as small, as it is supposed its motion

would be flow at first, if left to its gravitating power; so that a small power may keep it in its projectile course. For, 1st, No power but a resisting one can have this effect of keeping any projectile in an orbit. The dispute here with the present philosophers, is not by what agent they suppose gravitation to be performed? It signifies nothing tho' they should say, they don't determine whether it is spiritual or material; whether it acts by drawing or pushing. The question is, can any power which acts in a direction towards a centre, be combined with any other power, so as to maintain the motion of any body round that centre, without bringing that body either gradually into the centre by the uninterrupted application of its momentum, or by allowing it gradually to recede from it into irrecoverable eccentric distances by its unproportioned weakness? The whole science of mathematics cannot demonstrate that any power, but a resisting one, can produce the revolution of bodies in orbits, or that any power which uniformly pushes inward, can produce it.

2^{dly}, I PROVE, that that power of gravitation must be equal to the momentum of projection as a moving power, in order to its ballancing the direction of the planets equally between the directions of the two powers; and that according to the doctrine of the present philosophy, the resistance of the earth to the influence of gravity acting upon it, must be equal to what persons upon the earth, judging

judging of weight, would compute the earth to be; nor can it decrease in proportion, as it is supposed the quantity of its gravitating motion decreases by distance.

By the axioms of this philosophy it is established, that the momentum of motion in any body will be according to, what is called, its quantity of matter. Now, if the projection of the earth must act with so great a momentum, then in order to ballance it, gravitation must act with a restraining power equal to that nifus of power which would be at least necessary to sustain its weight, according to our ideas of weight here upon the earth; for no line which cannot sustain the weight of a body, can sustain the momentum of projection, and give it a circular direction. But a power, whose nifus would be sufficient to sustain the weight of the earth, or give its projection a circular direction, if applied in the direction either of drawing or pushing it to a centre, would give it the same velocity in that direction, as projection would give it in causing it to move in an orbit by the help of that restraining power.

Of the MOTIONS of the SATELLITES.

IT is no wonder, that notwithstanding the many and strong grounds of probability there are for the motion of the earth, yet the greatest astronomers have not taken upon them to maintain it as a matter of absolute

lute certainty, contenting themselves to reason upon it as a probable hypothesis. Among the perplexities which attend that highly probable system, I think the doctrine of absolute motion none of the smallest. It is certain, that all the phenomena of relative motion are in every respect the same as if the earth were at absolute rest; and it is not easy to conceive how that can possibly be, upon the supposition of the earth's motion.

THE phenomena of bodies moving in the same direction with the absolute motion of the earth, may be comprehended. The motion of bodies crossing the absolute motion of the earth is also intelligible, as represented and explained by a supposed diagonal of the two powers. But however well a person may be disposed to embrace that doctrine, it is no easy matter to satisfy ones self about the phenomena of bodies moving westward, or in an opposite direction to that of absolute motion. If we should suppose that a gun-ball fired point blank westward, does not really move westward, but is only resisted by the explosion from moving so fast east as the earth goes in her absolute course; may it not be asked, What is it that keeps the ball suspended while the earth proceeds on in its absolute motion? For the resistance given to the absolute progressive motion of the ball, can be no resistance to its following the course of its gravity; as we know of no example to illustrate or explain to us, how resistance applied horizontally will prevent a body from falling down to the ground

ground for a longer time, than it would take to fall if it were not resisted horizontally. If the absolute motion of a projectile in space, is only the momentum of its *vis inertiae* derived from the earth's motion; and if its apparent motion in a contrary direction is only the momentum of another *vis inertiae* derived from the explosion; what possible conception can be framed of two opposite *vis inertiae*, acting so as to prevent the body for some time from pursuing the course of its gravity.

ON the other hand, if relative motion westward is *real*, it seems to imply a plain contradiction; for no body can be supposed to move really eastward and westward at one and the same time.

BUT tho' the temporary motion of projectiles, which by the action of gravity are soon restored to the earth again, in order to partake afresh of the momentum of the earth's absolute motion, could be clearly accommodated to the doctrine of that motion: Yet how shall we apply it to self-moving bodies? This momentum of absolute motion, which all bodies are supposed to partake of, is not alledged to be maintained in them after they are separated from the earth, by any other means than their *vis inertiae*, or their retaining the quantity of motion once impressed on them. Now, no body can move itself in a direction opposite to its *vis inertiae*, until that is overcome. How is it conceivable then, that birds,
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for example, after they are separated from the earth, where they acquired their absolute motion, should still retain it all. Certainly every reluctance of theirs, in an opposite direction, while upon the wing, must destroy some part of their absolute motion, seeing these efforts have nothing to overcome but the quantity of absolute motion they are in; for they are not supposed to have any fresh momentum of absolute motion communicated to them, after they are lifted up from the earth. After they are aloft therefore, it is obvious they have it in their power to react, and destroy some of the momentum of their absolute motion or *vis inertiae*. This reasoning, which I can perceive no fallacy in, implies a great change of the phenomena, in regard to the motion of self-moving bodies; and yet in fact, as I have already observed, all the phenomena of motion are the same as if the earth were at rest. In short, this absolute motion which bodies partake of with the earth, is something which no re-action has any effect upon, and therefore we must conclude, it does not, it cannot depend upon the axioms of the present philosophy; else, by the rule of these very laws of motion, real re-action would have a sensible effect in destroying it.

I S H O U L D be extremely glad on my own account, as well as on account of others, who may be embarrassed with the doctrine of these two motions, if I could in any measure clear them up: But I may be well excused from under-

dertaking it, if I can be as easily excused for offering a consideration or two, without including which in attempting the solution of this doctrine, I apprehend it absolutely unsearchable. Whether they will throw any light upon it, I leave to the consideration of others.

First, I SUPPOSE, that if this earth moves, the atmosphere in which it is inclosed or immersed, and to which as a medium, I presume, all other bodies owe their powers and phenomena of motion, moves along with the earth as if it were one body therewith, and that the earth does not move thro' it: Or, in other words, the materials of the atmosphere, in all the earth's motion, preserves the same absolute structure in relation to the earth, however within itself it may be topically formed into different climates, upon the earth's surface. This is in some respect self-evident, upon considering the earth's diurnal motion: For if the atmosphere were not stationary, but the earth moved through it, it would follow of consequence, that once in twenty-four hours we would pass thro' all the different climates round the earth which belong to the same latitudes; and these are known to be very various. Therefore I apprehend the atmosphere is connected with the globe in the same manner as the ocean is with the land; and the motion of bodies in it is analogous to the motion of fishes in the waters.

THIS does not prevent every particular body from enjoying its own individual modification of the general atmosphere of the earth, which is proper to it wherever it moves, and to which, it may be supposed, is owing the phenomena of that absolute and relative motion observed in ships and other large moving bodies. A proof of this individual modification, in relation to all particular bodies, we have in the loadstone, electrical and other bodies, which discover any very singular phenomena or virtues in their natures, which exert themselves without the spheres of the bodies themselves. If I may be indulged in a very gross comparison, for giving an idea of the general atmosphere of the earth, and the individual atmosphere peculiar to every particular body in it ; I would compare it to the gummy inclosure which lint, cresses, and other mucilaginous seeds acquire by infusion in water.

AGAIN, I am much inclined to believe, that what we call gravity, and the supposed absolute motion of bodies, which belong to the earth, are nothing different. It is evident in the motion of projectiles and self-moving bodies westward, which, notwithstanding all that can be said, must be real as well as relative, gravitation alone is sufficient to preserve any of the absolute motion from being lost by a real one in an opposite direction. I am persuaded, if such an impossible thing may be supposed, that if a body which never had been upon the earth to acquire

quire its absolute motion, were introduced as near to the earth, as the greatest height to which any earthly body ever was projected, and there dropt, it would fall as perpendicular to the place it was over when let go, as any other body would do, which descended in consequence of its being thrown up from the earth. I own indeed, that this is in effect supposing, that the principle of gravity is a sphere which, in its different parts, uniformly preserves its relation to the parts of the earth directly under it, or in a line with it. But I am apt to think, if experiment could be made of it, this also would be found to be the nature of the magnetic attraction, so far as its sphere of action extends. If it should be alledged, that by this way of reasoning, I resolve the principle of gravity and the atmosphere into one and the same thing; I can only answer, that I can make no more of so dark a subject at present. This however, I am pretty clear upon, That as there is real motion in a contrary direction to that of absolute motion, and as no body can really move in opposite directions at the same time, at least not without the intervention or assistance of a medium, which partakes of the absolute motion of the earth; so neither can this supposed absolute motion be distinguished from the tendency of gravitation. Again, I think it must be incontestible, that all real motion, not in the direction of absolute motion, must destroy in whole or in part, that absolute motion which is preserved by no power but that of the *vis inertiae*.

N o w when we come to apply the theory of absolute motion to the satellites, in whatever light we can attempt to consider it, it becomes a matter absolutely inconceivable, nay impossible. In the first place, we know of no absolute motion communicated from greater to smaller bodies, but where they are so intimately connected that gravitation can at last, and that soon, overcome all their relative or projectile motion : But such is the situation and distance of the moon, in regard to the earth, and so remote is their connection, that the moon's supposed gravitation never has gained any thing upon her projectile motion.

Secondly, W e know of no absolute motion communicated from greater bodies to smaller ones, but where the bodies are known to have been in original contact, by means of their gravity, when they were first projected or put in motion ; so that their first motion must have been as one great body, and the relative motion must have been begun afterwards. But we have no reasonable foundation for even presuming that ever the earth and the moon were so connected ; and if they ever had been so connected, by all the laws of projection and gravitation we have given us to judge of, we can conceive no projection which could be made that gravitation would not soon destroy, and reduce the projected body again to its state of simple absolute motion, along with the larger body.

Thirdly,

Thirdly, THE moon, or any satellite, supposing their present distance to be their original one from the primary, could never, by means of the supposed weak connection of gravitation, correspond with the projection of the earth, so as to partake of her absolute motion. Let us suppose the moon placed at her present distance, and behind the earth, directly in the course of the earth's projection; in this situation, the moon being disposed to advance towards the earth at the slow pace of sixteen feet in a minute; at the same instant suppose the earth is projected away from the moon with the velocity of near a thousand miles in the same time that the moon would have advanced sixteen feet towards the earth: Can any person once suppose, that that imperceptible disposition in the moon to join the earth, in her projectile or absolute motion, would draw the moon into the momentum of the earth's absolute motion. This supposition is attended with the same manifest impossibilities, in whatever part of her area the moon can be considered at the moment of projection. If we suppose her in, or nearly approaching to, her first quadrature, then the gravitation between them, and the projection of the earth, lying nearly in the same direction, nothing could prevent their joining and collision in a few hours; for at that time, their mutual gravitation could have no effect in communicating the absolute motion of the earth to the moon, until they had met. The supposing that the
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projection of the moon round the earth commenced at the same instant with the projection of the earth, can in no degree render these impossibilities more accountable: For as it is not that projection which gives the moon her absolute motion, the whole apparent impossibility of the theory remains; and I may say, is renewed in every supposable circumstance every lunar month. For all the difficulties which attend the supposition of the moon's first conceiving her absolute motion in this manner, cast up in every course of the moon, and render it as impossible to suppose the moon's absolute motion can be maintained by such means, as it is that it could commence by them.

Fourthly, It is no less impossible, that the moon's absolute motion can be owing to a projection given herself, than that it can be owing to her gravitating connection with the earth, for this plain reason: Because the moon has, or is supposed and allowed to have, a projectile motion quite different from this, namely, her motion round the earth. But nothing in nature can be conceived more impossible, I believe every mathematician will allow, than for a body to move in two projectile directions at one and the same time. If five hundred projections, all in different directions, were applied at the same time, the projectile would fall into one course common to them all; but it is merely impossible, that more than one course can be produced, by any, either multiplicity, or repetition of projections;

jections; unless the repetitions are momentarily renewed without end.

A P P to all this, if it is true, that there can be no real motion in an adverse direction to absolute motion, unless there be either a destruction or weakening of that *vis inertiae*, which is the supposed principle for continuing absolute motion, then the projectile course of the moon round the earth, must soon exhaust and destroy her absolute motion. For every lunar month, the moon, for no less than the extent of four hundred and eighty-eight thousand miles, struggles in a course, which is in effect, diametrically opposite to the momentum of absolute motion, or of the *vis inertiae* carrying her in another direction; and this cannot happen without weakening and at last suppressing the whole momentum of the *vis inertiae*.

F O R these reasons, unless I can see them fairly removed, I must conclude, that even supposing these principles of the *vis inertiae*, gravitation, projection, &c. assumed by the present philosophy, are real, yet it is impossible to explain the celestial motions by them, without introducing some further principle of *resistance* also; which both prevents the planets from receding, and likewise from approaching nearer other than they do; and which acts as certainly in that manner, as the line does in the case of the ball vibrating or moving round by its means, or as a ball rolls in a bowl or hollow sphere.

UPON the whole, I conclude, There are only two powers within the compass of human conception, which can be considered sufficient to produce and maintain these lofty and intricate revolutions performed by the heavenly bodies. These are, either the direct and immediate efficacy of an omnipotent thinking agent, who can vary and bend the motions of all the orbs uninterruptedly according to his will, and with infinitely more ease than a man can move his hand, and whatever he holds in it, in any direction he pleases: Or, an inconceivably subtile and profound combination of mechanical powers, executed by that same artist who gives being and structure unerringly to every thing after its kind.

An Examination of the first Lemma of Sir Isaac Newton's PRINCIPIA.

AS Sir *Isaac Newton* proposes to demonstrate his principles by the method of *first and ultimate ratio's*, this method of demonstrating ought to be examined, for if the method itself prove fallacious, it is certain that all the demonstrations built upon it, must fall to the ground.

SIR ISACC's first lemma is, That quantities, and also the ratios of quantities, which constantly tend towards equality in any finite time, and before the end of that time approach nearer to each other, than for any given difference, becomes ultimately equal.

If you deny this (says the author) let them be supposed ultimately unequal, and let their difference be D , they cannot therefore approach nearer to each other than the supposed given difference D : But this is contrary to the hypothesis.

BUT is not this a false method of arguing? Suppose I cannot assign the difference between two quantities, will that prove them equal? It certainly will not; it will only prove, that the difference is too minute for my senses to measure and determine; if this lemma was to be admitted, it would prove that all quantities which are either so small as to elude the sense, or so large as to be incomprehensible, or incommensurable by it, must be therefore equal, but such a position is evidently absurd; it is certain therefore, that the difference of quantities does not depend upon our power to assign or determine the difference, but upon the quantities themselves; there may be a real difference between quantities, tho' we cannot determine it, as on the other hand quantities may be equal, which we cannot prove to be so, because we cannot assign their measures.

BUT it may be said, that Sir Isaac supposes the quantities to be constantly tending towards equality, but this ought to be expressed with more precision; for it is certain, that quantities may tend towards equality in such a manner that they never will become equal:

equal: On the other hand it is granted, that quantities originally unequal may tend towards equality in such a manner, as to become very soon equal: For instance, suppose, two lines, the one 12 inches, the other 6, to be both perpetually diminished by one half in equal times; it is obvious that these lines are constantly tending towards equality, yet they never will become equal. On the contrary, they will always preserve their original proportion to each other, tho' the difference between them will be perpetually diminishing; thus, the difference at first is 6 inches; the first bisection reduces the difference to 3 inches, but their proportion is not altered; the one is still double of the other: The second bisection reduces the difference to one inch and a half, but the proportion remains unaltered; the one is still double of the other. In short, if we continue the bisection without end, according to the mathematical doctrine of the infinite divisibility of matter, it is certain, that the difference between these two quantities may be diminished so as to become less than any given difference, and yet the original proportion remain unaltered, so that the one quantity shall be always double of the other; but it would be absurd to suppose, that one quantity should be double of another quantity, and at the same time equal to it.

ON the other hand, if we suppose these quantities, of 12 and 6, to be unequally diminished, the greater being diminished by 8, while

while the lesser is diminished by 2, this will presently reduce them to equality; but then it is plain, that the quantities are not proportionably diminished. In short, this lemma of Sir *Isaac*'s is so far from holding universally true, that it is plain it never can take place, in quantities either equally diminished or augmented; for while the one quantity is diminished or augmented in the same proportion as the other, their proportion to each other remains unaltered, and if that proportion was originally any proportion of inequality, it must remain perpetually the same, and never can be converted into the ratio or proportion of equality.

As to the quibble founded on the impossibility of assigning the ultimate difference between quantities perpetually diminished or increased, that it is no more than a quibble may be proved by applying it to the case of the hyperbole and its asymptote; it is well known that the property of these lines is such, that tho' they perpetually approach each other, yet they never will coincide; this is demonstrated geometrically, and is, I believe, among other arguments adduced by the mathematicians to prove the infinite divisibility of matter; but if we admit the method of proof used by Sir *Isaac*, we must set aside this property of the hyperbole and its asymptote, for as these are perpetually approaching to each, so if infinitely produced, their distance must ultimately become less than any possibly assignable distance, therefore they must ultimately coincide; if you deny it, let their ultimate distance be D , they

cannot therefore approach nearer than the distance D , which is contrary to the hypothesis; this reasoning is *mutatis, mutandis*, precisely the method of proof used by Sir Isaac, and as it directly contradicts a geometrical demonstration, it is surprising how it should be admitted by geometricians.

IT would be tedious to undertake a particular examination of all the subsequent lemmas of this celebrated author. It is plain, that as far as they depend upon the first, they stand or fall with it; but it is necessary to take particular notice of the seventh lemma, and the third corollary deduced from it. The lemma is as follows: The same things being supposed (alluding to the preceding lemma) I say, that the ultimate ratio of the arc, chord, and tangent to each other, is the ratio of equality.

THE third corollary drawn from this lemma is, that in all reasoning concerning ultimate ratio's, all these lines, (viz. the arc, chord, or tangent) may be indifferently used for each other.

I SHALL omit the examination of the author's demonstration, because I apprehend, it may be demonstrated geometrically, that the ultimate ratio of the chord, arc, and tangent, neither is, nor can be the ratio of equality; and it would be absurd to suppose, that geometry can demonstrate two contradictory propositions to be both true. The demonstration that the ultimate ratio of the chord, arc, and tangent, cannot be the ratio of equality, is as follows.

IT is known, that it is impossible to draw two right lines which shall both touch the same circle in one and the same point; it is also certain that the angle of contact, formed by the tangent and periphery of the circle, at the point of contact, is less than the least possible rectilinear angle; it is also certain, that thro' the point of contact different circles may be drawn, each of them forming angles of contact with the same right line, which will be less and less, as the radius is increased, tho' the greatest of these angles of contact is less than the least rectilinear angle which can possibly be drawn.

THESE things being allowed, suppose a circle drawn with any radius, let us call it A, and let it be touched by a right line in a point C, the angle of contact at C, is acknowledged to be less than any rectilinear angle which can possibly be drawn; thro' the point C, let a second circle be drawn with a greater radius, so as it may be touched in the point C with the same right line, which touches the first circle A in the same point; call this second circle B; it is plain, that the angle of contact formed by the tangent and the periphery of the second circle B, is less than the angle of contact, which the same tangent forms with the periphery of the first circle A. Now, suppose the arc of the second circle B, to be diminished towards the point C, till it becomes, in the stile of the mathematicians, infinitely small, let the tangent be diminished towards the same point, in the same manner, we will then have an infinitely small arc, and

and an infinitely small tangent, touching each other, and also another circle A, in the same point C; according to Sir *Isaac*, the ultimate ratio of the infinitely small arc of the circle B, and of the infinitely small tangent, are the ratio of equality, and the arc and tangent may be used for each other; of course, the infinitely small arc of the circle B, will become a right line; and we will have two different right lines, both touching the same circle A, in one and the same point C; and we will also have a rectilinear angle, less than the angle of contact formed by the tangent with the periphery of the circle. But both these are impossible, and therefore it must be impossible that the ratio of the tangent and of the arc of the circle B, let them be diminished in what manner you please, can ever become the ratio of equality.

THE corollary is obvious, that therefore in no kind of reasoning, The chord, arc, and tangent, can ever be used indifferently for each other; right lines and circular lines, are lines different in kind, which have different properties, and diminish them at pleasure, even to a mathematical point, yet each of them in that state of diminution retains their specific properties, unaltered and unchanged; they cannot therefore be used indifferently, and all reasoning, which is founded upon using either the chord or tangent for the arc, or *vice versa*, the arc for the chord or tangent, must be fallacious and illusory.